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Numbers of Red-backed Shrikes *Lanius collurio* in different habitats of South Africa

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Red-backed Shrikes are declining in central Europe, particularly in areas of intensified agriculture. As a first step towards describing the

situation of the species in its non-breeding range Bruderer & Bruderer (1993) presented an up-dated distribution map of the species in southern Africa. It was shown that the distribution of Red-backed Shrikes coincides with the Savanna Biome according to Rutherford & Westfall (1986). Within the Savanna Biome the arid savannas (Huntley 1982) are preferred to the moist savannas. A more detailed association of the species' distribution with vegetation units based on Acocks' (1988) *Veld Types of South Africa* showed that Kalahari Thornveld and Arid Lowveld were most preferred. Due to the lack of quantitative information on the species' distribution, the present study aims at rough estimates of densities in order to complement the atlas information for part of the non-breeding range and to compare habitat preferences in different areas as a basis for more detailed studies on the ecology of the species.

Methods

Terminology and general rules. The terms "count, survey, census, strip transect" are used as proposed by Ralph (1981). Specific adaptations are described below. The counts were restricted to the shrikes' main activity periods which were determined by observations on their behaviour (unpubl. data). Red-backed Shrikes in the non-breeding area tend to expose themselves to the sun at sunrise; territorial behaviour and calling are most pronounced at that time. During the following two to three hours foraging has priority. When it becomes warmer after about 10 o'clock, the birds gradually tend to seek shade and are less conspicuous; during the hottest period of the day most are completely hidden. A second phase of activity occurs during the last two hours before sunset, with intense calling at sunset. In cool and overcast weather, the active period may be slightly extended. Birds were mapped on transparent sheets fixed to orthophotos or 1:10 000 maps of the main study areas. Where no such documents were available, distances along the transect line were read from the automatic counter of the car and distances off the line were estimated.

Strip transects by car. To cover large distances, or where leaving the car was not possible (e.g. in the Kruger National Park), counts were done by driving at a speed of about 7 km/h, one observer surveying the left and another one the right side of the road. In open areas or where the bushes were low and well separated, a strip of 50 m on both sides of the road could be surveyed (VW-Combi providing a relatively high observation platform). The car was slowed down or even stopped when the bushes could not be checked adequately at the basic speed. In areas with denser bush (and no possibility of leaving the car) the census strip was reduced to 25 m off the transect line.

Strip transects on foot. In areas with orthophotos or comparable maps, off-road strips could be covered. In areas with dense bush, where leaving the car was possible, car transects were supplemented by two persons walking for a known distance about 25 m off the road in order to achieve a strip width of 50 m to both sides of the road.

Area surveys. 1 km^2 plots at "Deelkraal" and "The Ridge" were covered by a series of strip transects of two observers walking 50-75 m apart. At "Verene" daily driving along the road and frequent walking parallel to the road resulted in a complete census of 15 ha and provided data for detectability estimates.

Detectability of Red-backed Shrikes and density estimates. Good knowledge of the numbers of birds in the census area at "Verene" and of some individuals in other areas allowed tests of the detectability of these individuals when driving past at normal counting speed. Provided that the main parts of these birds' territories were inside the counting strip, the detection rate was about 60% for males in single one-visit counts during the main activity periods. The corresponding detection rate for the more cryptically coloured, and often less conspicuously perching females was about 40%. In the case of our area surveys with two observers, we assumed that the detection rate was slightly higher than in the tests. In unknown areas, such as in the one-visit strip transects by car, where the preferred perches are not familiar to the observer, the detection rate is probably lower, and also depends on habitat structure. In spite of comparability

problems (mentioned in text and tables), we transformed the counts of Red-backed Shrikes into densities for rough comparisons between regions and habitats.

Association of vegetation types with Red-backed Shrike distribution. Acocks (1988) has provided South Africa with an excellent set of vegetation maps and with a classification of vegetation types, described by climate, soil characteristics, and plant associations; most of them illustrated by photos. Seventy veld types are included; those relevant for the Red-backed Shrike are listed in Bruderer & Bruderer (1993). The allocation of an area to a certain veld type was based on Acock's (1988) maps. In the main study area, the Transvaal Province, nine veld types were relevant for the Red-backed Shrike (Table 1).

Study areas

Names of sites always refer to the 1:250 000 topographical maps of South Africa. The main study areas (site 1 in Fig. 1), situated 25 km E of Nylstroom around the Nyl Floodplain, were surveyed mainly during December 1989 and February 1990. The area as a whole belongs to the Mixed Bushveld (Acocks 1988, Frost 1987). In fact it is a mosaic of several veld types which can be divided into two main communities: (a) those on the higher parts of the landscape, mainly on well-drained (acidic) sandy soils derived from weathering sandstone and conglomerate, with mainly broad-leaved bushes and trees (e.g. *Ochna pulchra, Terminalia sericea*); (b) the microphyllous thornbush savannas on alluvial clay soils of the bottomlands, which are dominated by *Acacia* spp. The woodlands are interrupted by open areas, such as valleys or old man-made clearings. In spite of having the same climate, the microphyllous woodland shows affinities to the arid savannas, the broad-leaved woodland to the moist savannas (Tarboton 1980). Four plots were selected in order to get an idea of the distribution of shrikes in the different habitats of this area (Table 2): (1) 16 km of strip transects along the vley in the Nylsvley Provincial Nature Reserve (a former farm), with three parts offering a mixture of open grassland, Acacia savanna and broad-leaved savanna; (2) 1 km^2 of partly cleared, cattle-grazed grassland covered with 5 up to 50% of (mainly *Acacia*) bush on the farm "Deelkraal"; (3) 1 km^2 of recolonized grassland on old lands, partly cleared Acacia bush and mixed Bushveld in the farm area "The Ridge"; (4) a 15 ha plot of mixed (mainly broad-leaved) Bushveld on the farm "Verene", where we lived. The sites outside the Nyl area were visited only once, mainly in January 1990 (Table 1). Those within Transvaal Province are indicated in Figure 1.

Densities in different areas

Table 1 is mainly based on one-visit strip transects (two exceptions marked out by a footnote are explained below). Detection rates may be slightly higher in multiple strip transects and considerably higher in the area surveys (Table 2, see below). In spite of these limitations, the two tables show the same general features as the atlas distributions for Transvaal (Bruderer & Bruderer 1993): highest densities occur in the semi-arid savannas of the Lowveld and the Limpopo basin, lower densities in the central parts of northern Transvaal, where on the slightly higher relief broad-leaved savannas prevail. Within the Bushveld there is a decrease from N to S, the low densities at Vaalbosch being recorded in an optimal Red-backed Shrike habitat with open mixed scrub of mainly 1.5 m height. In spite of intensive search and apparently suitable habitats, no Red-backed Shrikes could be found in the well developed bush along the slopes of the Willem Pretorius Game Reserve (Highveld, between Kronstad and Bloemfontein) and in the bush associated with dry riverbeds in the Karoo National Park (Nama-Karoo, near Beaufort West); these are not included in Table 1. In addition to the general trends, Tables 1 and 2 indicate wide variation of densities within the same veld type and within short distances.

TABLE 1

Density estimates of Red-backed Shrikes (to nearest 0.5 birds) and proportion of males in different areas and habitats of Transvaal, based on single one-visit strip transects; arranged according to increasing densities. Veld Types according to Acocks (1988)

Site no. (Fig. 1)	Geographic name of site (Veld Type, Acocks 1988)	Surface and habitat in counting area	Density birds/10 ha	% males[2] Jan	% males[2] Feb/Mar
2	Percy Fife (Sour Bushv.+Sourish Mixed Bushv.)	250 ha mixed bush & woodland, hill	<0.5	50	
9	Phalaborwa-Letaba (Mopani Veld)	200 ha dense, rather low Mopane bush	1	50	
13	Vaalbosch (Turf Thornveld)	80 ha low mixed scrub with many Acacia	1.5		65
8	Punda Maria (Lowveld Sour Bushv.)	200 ha broad-leaved woodland	1.5	55	
11	Klaserie (Arid Lowveld)	80 ha open broad-leaved woodl. Mixed Red-bushwillow/Mopane	2	50	
4	Kranspoort (Sourish Mixed Bushv.)	50 ha broad-leaved woodland & bush	2	60	
3c	Ruigedraai (Mixed Bushveld)	35 ha low, mainly broad-leaved scrub, hill	2		50
5	Venda/Dzanani2 (Sourish Mixed Bushv.)	20 ha overgrazed, secondary Acacia bush	3	65	
3b	Ruigedraai (Mixed Bushveld)	55 ha low mixed scrub, hillfoot	3.5		85
6	Langjaan (Arid Sweet Bv.+Mopani Veld)	90 ha low mixed scrub Acacia/Terminalia prunoides	5	60	
7	Malongavlakte (Mopani Veld)	30 ha overgrazed, secondary Acacia bush	6.5	60	
3a	Ruigedraai (Mixed Bushveld)	70 ha low mixed scrub, plain	6.5		75
8	Punda Maria (Lowveld Sour Bushv.)	15 ha several clearings with Acacia in broadl. woodland	8 [1]	65	
11	Klaserie (Arid Lowveld)	6 ha clearing in broad-leaved woodland	8 [1]	50	
11	Klaserie (Arid Lowveld)	10 km of (low surface) grass strips along roads	(10)	60	
10	Satara (Arid Lowveld)	100 ha open Acacia scrub Knobthorn-Maroela Veld	12	65	
12	Olifants (Arid Lowveld)	100 ha open Acacia scrub Knobthorn-Maroela Veld	15	55	

[1]For censuses on small patches with low bush, detection rates were assumed to be close to 100%. The original figures were reduced by 50% to render them comparable to the one-visit strip transects with an estimated detectability of 50% (see text).

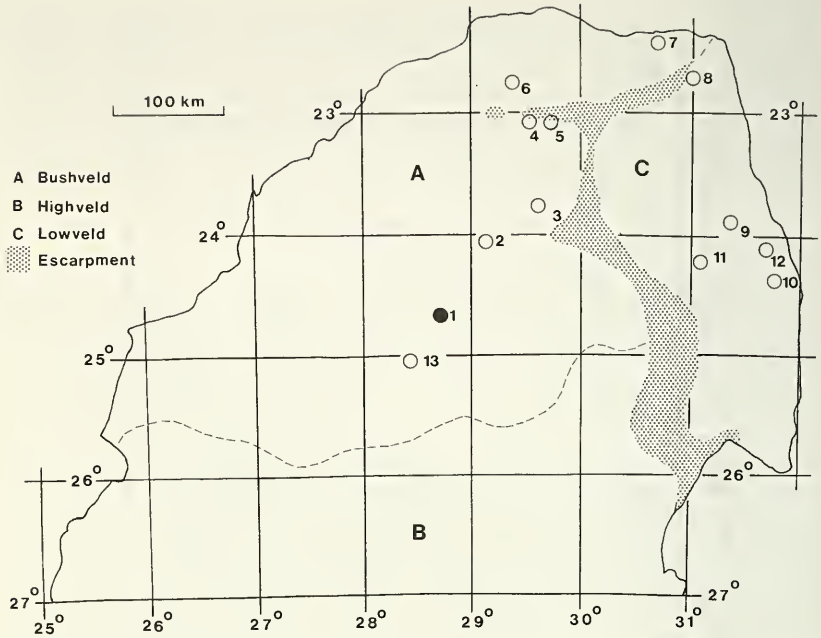

Figure 1. Study areas in Northern Transvaal: 1, Nyl area (main study area; dark point); 2, Transvaal Provincial Nature Reserve Percy Fife; 3, Air force Reserve Corbadraai (former farm Ruigedraai); 4, Kranspoort (road at southern edge of the Soutpansberg); 5, Venda/Dzanani 2 (road at southern edge of the Soutpansberg); 6, Transvaal Provincial Nature Reserve Langjaan; 7, Malongavlakte; 8, Punda Maria; 9, Phalaborwa-Letaba; 10, Satara; 11, private Nature Reserve Klaserie; 12, South of Olifants; 13, farm Vaalbosch. Boundaries between the geographical regions Bushveld, Highveld, and Lowveld dashed. Escarpment shaded.

Variation of densities with habitats

In the geographical area of the Lowland (Fig. 1), densities varied from 1 to 15 birds/10 ha due to important differences in local habitat structure which is far below the resolution of Acocks' (1988) maps. The distribution was particularly patchy in the Klaserie and Punda Maria area (Table 1). Low densities (1–2 birds/10 ha near Punda Maria, about 2 birds/10 ha at Klaserie) were recorded in strip transects in broad-leaved woodland with high trees. High densities occurred on clearings with Acacia. Such small areas with low bush were easily surveyed completely in a relatively short time. The resulting densities (e.g. 10 birds on 6 ha at Klaserie corresponding to 16.6 birds/10 ha, or 2–3 birds on several clearings of 1–3 ha around Punda Maria, corresponding to 7–30 birds/10 ha) are not directly comparable with the normal strip transects. Taking into account that the usual detectability of the birds in one-visit strip transects is about 50%, the densities for these patches (with probably close to 100%

TABLE 2

Density estimates of Red-backed Shrikes and proportion of males in the Nylsvley area (Mixed Bushveld), based on mean values of multiple strip transects (b, c, d) and area surveys (a, e, f). The higher detection rates in the area surveys are accounted for by reducing the census data (provided in brackets) in order to be comparable to strip transects (see text for explanation)

Ref. no.	Site (no. and veld type of Acocks 1988)	Surface and habitat in counting area	Density birds/10 ha	% males Nov/Dec	% males Feb/Mar
1a	The Ridge	100 ha mixed bush & secondary grassland	0.7(1.1)	25	50
1b	Nylsvley Reserve S	65 ha Acacia woodland+Mixed Bv. along vley	1.5	50	55
1c	Nylsvley Reserve centre	75 ha open broad-leaved bush+Acacia along vley	1.8	50	65
1d	Nylsvley Reserve N	50 ha open broad-leaved bush+Acacia along vley	2.5	45	75
1e	Verene	15 ha open mixed & broad-leaved bush	2.5(4)	30	35(55)[1]
1f	Deelkraal	100 ha Acacia bush & grassland	2.5(3.8)	45	(80)[1]

[1]See discussion for variation in the percentage of males.

detectability) were reduced to 50% for inclusion in Table 1. High densities were also recorded in one-visit strip transects along the roads towards the entrance of Klaserie (5–15/10 ha on narrow grass strips bordering the road; included in Table 1 by an average value of 10 birds/10 ha). Very low densities occurred in the dense Mopane bush with nearly complete absence of herbaceous layer between Letaba and Phalaborwa. In the open Acacia scrub (dry Knobthorn Veld) around Satara, Red-backed Shrikes occurred at a nearly uniform high density. The fact that the proportion of males is higher than expected is discussed below.

In the geographical area of the Bushveld (Fig. 1) variation was less pronounced. Nevertheless, in the Ruigedraai area, the densities varied from 6.5 in the plain to 2 birds/10 ha on the dry stony hills within a distance of 5 km. In the Nyl area (Table 2) densities were lower in areas with a large proportion of open grassland (The Ridge), increasing in open bush areas, and decreasing again where bush and/or tree cover was too dense (Nylsvley South). The densities in the Nylsvley Reserve are based on multiple strip transects, the others on area surveys. In order to render the results of the surveys comparable with the transects, reduced figures are given in addition to the survey data (in brackets). In the case of "The Ridge" we were able to detect 60–70% of the known birds by strip transects; thus, the comparable value is 0.7 birds/10 ha, while the total density was at least 1.1 birds/10 ha. At "Verene" the total density comprised at least 2 males and 4

female-plumaged birds on a surface of 15 ha in November/December (corresponding to 4 birds/10 ha); normal strip transects covering 12 ha of the same area resulted in a mean of three birds detected, corresponding to the 2.5 birds/10 ha which are given as the "comparable" figure. The "comparable" value for "Deelkraal" is the mean derived from three area surveys with two observers. On 11 November and 1 December an improved coverage with 4 observers revealed a density (closer to the real density) of 3.5 birds/10 ha which is given in brackets. An interpretation of the variability in sex-ratios is given in the discussion.

Discussion

Methods

The limitations of the present study are mainly attributable to the restricted time available (only one season) and the different methods used. Densities may differ between years and vary as the season progresses. The detectability is lower in strip transects than in area surveys by two persons and is generally reduced in higher and denser vegetation. Behavioural differences between males and females may cause further bias. Atlas reporting rates (Bruderer & Bruderer 1993) tend to level out variation in time and space, but provide no direct information on densities. Sporadic occurrence in time and space may already provide reporting rates of 1–5% in a conspicuous species, while densities ranging from 5 to 15 birds/10 ha or even up to 80 birds/ha (Herremans 1993) are all included in reporting rates of 50–100% (Bruderer & Bruderer 1993), which may indicate some sort of logarithmic relationship between reporting rates and densities in a conspicuous species.

The detectability seemed to vary around 50% (60% and 40% for known males and females, respectively); it was assumed to be slightly lower in one-visit strip transects and slightly higher in area surveys done by two persons. The assumed detectabilities seem to be realistic in a one-species survey of a conspicuous species. Hildén (1981) estimated the mean efficiency of the Finnish line-transect method for a mixture of species to be in the order of 45–50% in one visit, while Järvinen & Väisänen (1981) suggested 60–65%. Diehl (1981) emphasizes the variation in detectability at different phases of the breeding cycle of Red-backed Shrikes, but deals with detectabilities similar to ours. With a detectability of 50% one would have to double the densities recorded in one-visit counts to obtain rough estimates of real densities, or one has to reduce complete censuses accordingly to render them comparable to strip transects (Tables 1 and 2).

Densities in different areas and habitats

Tarboton (1980) provides the only comparable data on densities in South Africa. In the Nylsvley area he found 19 birds/100 ha in Acacia Savanna and 2.7 birds/100 ha in Burkea Savanna. Our Deelkraal data (25 birds/100 ha) closely match Tarboton's Acacia census. Our counts

did not cover the sparsely populated Burkea Savanna. Like our counts, Tarboton's censuses emphasize the fact that within a few kilometers there may be a mosaic of veld types. This local variation in the veld types and habitat structure is reflected in the density of shrikes (Tables 1 and 2). As Red-backed Shrikes are very opportunistic in their habitat selection in the non-breeding area, the densities in a certain area change with season; local concentrations may build up within a matter of days or even hours when large amounts of food become available (e.g. after cattle grazing, or when termites are swarming).

Counts by Herremans (1993) in the core area of the Red-backed Shrike's non-breeding area (i.e. different subkalahari habitats in Botswana) provide another basis for comparison. His density estimates range from 1–3 birds/10 ha in dense broad-leaved vegetation and in open grassland to 3–39 (exceptionally 80) birds/10 ha in Acacia and open broad-leaved vegetation. The lower densities match our Bushveld counts, while our Lowveld counts come into the lower half of the densities recorded in good subkalahari habitats. If we accept the assumption of Herremans (pers. comm.) that, by using the call of a Pearl-spotted Owl *Glaucidium perlatum* to provoke alarm-calls of all shrikes present in the immediate neighbourhood, his recorded numbers correspond to 100%, our Lowveld counts of 2–15 birds/10 ha (Table 1), which are assumed to represent about 50% of the birds present, may come close to the subkalahari numbers when extrapolated to 100% (=4–30 birds/10 ha).

A preliminary analysis of the habitats of Red-backed Shrikes in the northern part of Transvaal (unpubl.) shows that, in general, low scrub (1–3 m high) is preferred to higher bush and trees; open bush (10 to 50% coverage) is preferred to dense coverage or open grassland. This corresponds to the distribution of Red-backed Shrikes in eastern Botswana, where Herremans (1993) also observed reduced densities in open grassland and in dense broad-leaved vegetation compared to vegetation of medium density (see above). Similarly, in the herbaceous layer, medium cover and restricted height is favoured: low grass (less than 50 cm) seems to be preferred to high grass, and medium grass-cover (50 to 80%) to bare sand or dense grass. These preferences, which are also reflected in the preference for certain veld types, are related to the hunting behaviour of the Red-backed Shrike and to the availability of large, mainly ground-dwelling insects. Red-backed Shrikes prefer perches 1.5–2 m high with open space around, and a herbaceous layer which supports many insects but leaves sufficient open patches to detect and catch them on the ground.

A discrepancy exists between the high preference of Red-backed Shrikes for the veld type "Mopani Veld" (Bruderer & Bruderer 1993) and the very low densities found in the dense Mopane bush with very sparse undergrowth between Phalaborwa and Letaba (Table 1). The explanation may be, that the veld type defined by Acocks (1988) is usually not a 'monoculture' of *Colophospermum mopane*. It ranges from grassland with more or less scattered trees and/or bushes dominated by *C. mopane* to dense monospecific Mopane woodland.

Sex-ratio

The percentage of males in all the one-visit samples (Table 1) is higher than expected according to the sex-ratio in breeding populations (see below). Over-representation of males is also known from other comparable counts. Becker (1974) found only one female among 30 birds sitting (in early April) on wires along the Kalkfeld–Okaputa railway (Namibia). D. Ludwig (*in litt.*) counted (in February) 6 *L. collurio* on a line transect of 2 km near Windhoek, 5 of which were males. P. J. Mundy (*in litt.*) states that the Red-backed Shrike was the most widespread and probably the commonest shrike in the southwest corner of Zimbabwe (end of March 1990) and that males outnumbered females by at least ten to one. From the difference between one-visit strip transects (Table 1) and area surveys (part of Table 2) in our study, we assume different behaviour which may result in a local segregation, with males perching conspicuously along open patches or strips (such as roads), while females behave more secretively and may be less prone to use exposed perches. This would be similar to the behaviour of the sexes in the breeding area.

As moult (which allows sexing of immatures increasingly from January onwards) progresses, the percentage of sexable males changes with season. If there is no geographical segregation of the sexes one would expect a sex ratio close to 50:50. A balanced sex-ratio was observed in the Jura mountains (U. Leugger pers. comm.) and in the best shrike areas in the Swiss Alps (Engadin) where M. Müller (pers. comm.) noted usually 1 or 2 surplus males among 150 to 200 birds in the years 1988–1991. He also reports that usually between 45% and 50% of the birds present are yearlings. Thus, we have good reason to assume a sex-ratio of 50:50 and a ratio of young to adult birds of 50:50 in the non-breeding range. When all males have reached a moult stage which allows sexing in the field in February (own unpubl. data, based on skins) we would expect 25% sexable males in December and between 25 and 50% from the beginning of January to mid-February. Thus, in Table 1 the expected percentage of males during January is of the order of 40%, and in February/March 50%, which is lower than observed in both cases. In Table 2 the expected value for November/December is 25%, a value which is closely matched by the censuses in the mixed Bushveld at "Verene" and "The Ridge". The Acacia bush at "Deelkraal" shows a higher percentage of males although the censusing methods were the same. This raises again the question of habitat segregation between males and females which was put forward as a hypothesis by Bruderer & Bruderer (1990), for which there are also indications from Botswana, where Herremans (pers. comm.) found that females preferred denser vegetation than males.

Comparison with densities in Europe

In Europe the species occurs mainly in areas where agriculture is still traditional, allowing a mosaic of hedges, cultivated fields, fallows, and pasture land. In Germany, Jakober & Stauber (1987) found 1–6 pairs/10 ha in small areas with optimal habitats. Such high densities occur over fairly large areas along open slopes of the Jura

mountains and in the dry inner Alpine valleys of Switzerland (Wallis/Lower Engadin) where 5–38 pairs/100 ha were recorded (Dell'Oca 1987, Schifferli 1989, Rudin 1990). Highest densities are reached in the Lower Engadin, where 30 of about 100 test areas of 50–200 ha showed more than 10 pairs/100 ha; 9 of these held more than 30 pairs/100 ha, 5 more than 40 and one 105 pairs/100 ha (Müller 1990). Recorded densities (about 50% of real densities) in Tables 1 and 2 can be directly compared with the number of pairs (2 birds) in the breeding-season censuses. Most of them compare well with those in optimal habitats in Switzerland. The high densities in the Lowveld and the Limpopo basin are of the same order as the Engadin values. The highest values (Satara, Olifants) are clearly higher than the highest breeding densities and are valid for large areas. If we bear in mind the fact that breeding pairs have to feed 3–5 young and enlarge their territories soon after the fledging of the young, we may conclude that the best breeding areas in Europe support a similar number of full-grown birds per unit surface as the arid savannas of southern Africa.

Summary

Strip transects and area surveys in the South African parts of the Red-backed Shrike's non-breeding range provided density figures for different areas and habitats. Based on an estimated average detection rate of 50%, these recorded densities have to be doubled for estimates of real densities. In Transvaal Province, the highest densities of 10–15 birds/10 ha were recorded in semi-arid parts of the Lowveld. In the Bushveld 5–6 birds/10 ha were counted in the north, decreasing to less than 2 birds/10 ha further south. Comparing densities with reporting rates from the southern African bird atlas projects suggests some sort of a logarithmic relationship between reporting rates and densities in this conspicuous species. Wide variation of densities occurs due to patchy habitat. Highest densities were recorded in arid savanna types of medium coverage and height. The observed sex ratios, which are usually distorted in favour of males, may be explained by different behaviour and local habitat segregation of the sexes. An attempt to compare the even more patchy breeding densities in Europe with the non-breeding densities indicates that the best breeding areas in central Europe support similar numbers of full-grown birds as the arid savannas in southern Africa.

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The present state of pelican populations (*Pelecanus onocrotalus* and *P. crispus*) in Kazakhstan

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Only the White Pelican *Pelecanus onocrotalus* and Dalmatian Pelican *P. crispus* are found, in small numbers, in Kazakhstan. They inhabit large reservoirs, lake systems and the deltas of several large rivers. Due to anthropogenic influences, especially land reclamation, the